The Realization of Inflatable Array Antenna

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JPL/NASA's deep-space exploration and Earth remote sensing programs have been placing emphasis on reducing the mass and stowage volume of their spacecraft's high-gain and large aperture antennas. To achieve these goals, the concept of inflatable planar array antenna has recently been introduced at JPL. Because the planar array's flat aperture is a "natural" surface, its required surface tolerance is much easier to be maintained by the inflatable structure than that for a specifically curved surface such as a parabola. In addition, a **planar array** offers the possibility of wide-angle electronic beam scanning. Certainly, to realize this inflatable array antenna technology, several technical challenges remain to be resolved. In the RF area, it is essential to mitigate the array's weaknesses of narrow bandwidth and poor efficiency. In the mechanical area, the development of the inflatable structure rigidization technique, controlled deployment technique, and the structure dynamic analysis technique are inevitable.

Two **inflatable array antennas** that were developed recently are a 3.3m x 1.0m L-band **synthetic aperture radar (SAR)** array for Earth remote sensing application and a 1.0m diameter X-band **reflectarray** for deep-space telecom application. The L-band SAR array is a 1/3 size technology demonstration model of the future full-size (10m x 3m) array. It consists of a rectangular frame with an inflatable tube that supports and tensions a three-layer thin-membrane radiating surface with microstrip patches, ground plane, and microstrip power division lines. The measured results show that the antenna has achieved the required bandwidth of 80 MHz at the center frequency of 1.25 GHz and a peak gain of 25.2 dB with an aperture efficiency of 52%. The antenna has a total mass of 15 Kg with an average of 4.3 Kg/m^2, which includes the inflation system and its container. It is projected that the full-size array would achieve an average mass of 2 Kg/m^2. The membrane surface achieved the required global flatness of less than $\pm$ 1cm and local flatness of $\pm$ 0.75 mm. The second inflatable array antenna is an X-band reflectarray, which has an inflated torus tube that supports and tensions a 1.0m diameter two-layer-membrane reflectarray surface. The top layer has many isolated microstrip patches and is separated 1.3 mm from the bottom ground plane layer. A set of inflated tripod tubes is attached to the torus as struts to support the feed horn. The same tube and thin-membrane materials are used here as that described above for the SAR array. This inflatable antenna structure achieved a mass of 1.2 Kg (excluding the inflation system). The antenna achieved good radiation pattern with both peak sidelobe and peak cross-pol levels below –18 dB. The overall antenna efficiency was measured to be 37%, which could be improved in the future to become higher than 50%. The performances of both above antennas have proven that the inflatable array antenna technology is now realizable.